

The Analysis and Research of Highway Operation Period Carbon Measurement Model Based on VB.net Technology

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Abstract

With the rapid development of highway construction and automotive industry, the transportation industry is one of the main carbon source. In the paper, the carbon measurement model established through the analysis of factors influencing highway carbon emissions. "Turner" model was used to prove the validity of the carbon measurement model. The CO₂ concentration measurement software has been completed based on VB.NET technology. Finally, the carbon measurement model was verified through examples.

Keywords

Highway Carbon Measurement; Operating Period; CO₂ Concentration Diffusion; VB.net

Introduction

With the rapid development of highway construction and automotive industry, the transportation industry as one of the main sources of carbon emissions is an important area of international greenhouse gas emissions and global climate change. Therefore, higher requirements for energy saving and emission reduction are necessary. In the paper, carbon emissions model of highway operating period was established according to influence factor of carbon dioxide emissions, and the calculation results were compared with the measurements.

The Factors of Highway Carbon Emission

Factors influencing highway carbon emissions can be divided into three categories by comprehensive analysis, that is, vehicle factors, road itself factors, natural state factors.

Vehicle Factors

In the paper, the study is on highway for carbon

emission, but fuel is consumed to produce carbon dioxide in the process of the vehicle, so the vehicle factor is the most direct factor. The main vehicle factors include motorcycle type, speed and traffic flow; speed is the most direct factor, There is a nonlinear analytical relationship between carbon emissions and speed. Traffic is the reflection of carbon emissions in the number of accumulation.

Road Itself Factors

Traffic state affects highway features, so road factors are the most important indirect influence factors affecting carbon emissions which include highway geometric features, pavement characteristics and misclosure; among which geometric features are mainly flat vertical and horizontal geometry parameters, horizontal radius, longitudinal slope degree and so on; while pavement characteristics are mainly pavement type selection and pavement roughness which affect carbon emissions as a cofactor. Misclosure contains the intersection in the road, and intersection includes toll station, interchanges, signal intersection, service area and so on. In contrast, closed sections does not contain intersection sections.

Natural State Factors

Highway performance is greatly affected by the natural environment, thus indirectly influencing the highway carbon emissions. Natural state factors including climate, terrain, etc. are incidental factors, and not easy to control, so there is no quantitative research in the paper.

Establish Carbon Measurement model

Establish carbon measurement model during closed section load of operation period

Carbon accounting model was established according to highway carbon emissions factors. The vehicles of operation are divided into six kinds of vehicle models based on different carbon emissions during operation period. The model was shown as following:

$$Y_F = 3.65 \sum_{i=1}^6 \sum_{j=0\%}^{8\%} K_m K_i L_j \frac{T_i}{\lambda_i} [m_i + (p_i L_j + q_i h_i)] \left(\frac{a_i}{v} + b_i + c_i v + d_i v^2 \right) \alpha_i \beta_i U / \theta_i \quad (1)$$

K_m is influence coefficient of pavement type, K_i is influence coefficient of pavement roughness, T_i is The carbon conversion coefficient of the vehicle model, $L_{|j|}$ is slope length, λ_i is adjustment coefficient of slope and slope length relationship, v is vehicle speed, θ_i is proportional to modeling the i models, β_i is the proportion of actual traffic design of traffic flow, U is design traffic volume, θ_i is coefficient of model conversion, m_i, p_i, q_i, n_i are influence coefficients of slope, while a_i, b_i, c_i, d_i are influence coefficients of speed.

Test Carbon Measurement Model

Test Principles

Traffic flow and highway factors have been known. The line source emission rate of road is calculated by carbon accounting model. The CO₂ density of each measuring point is calculated by "Turner" model. Theoretical values compared with the CO₂ density values of field measured, which shows that carbon measurement model is reliable

Theoretical Basis

In the paper, "Turner" model used as the carbon dioxide diffusion model has been applied on the condition while the subgrade height is zero. The midpoint of test section is taken as the origin of coordinates. Along the test section of highway is defined Y-axis. It is assumed that the mainstream direction of the wind is perpendicular to the measured road, so the mainstream direction of the wind is defined as X-axis, Z-axis perpendicular to the x, y-axis.

the main direction of the wind is perpendicular to the measured road. The model was shown as following:

$$C = \left(\frac{2}{\pi} \right)^{\frac{1}{2}} \frac{Q}{\bar{u} \sigma_z} \operatorname{erf} \left(\frac{y_o}{\sigma_y \sqrt{2}} \right) \quad (2)$$

Where:

$$\operatorname{erf} \left(\frac{y_o}{\sigma_y \sqrt{2}} \right) = \frac{2}{\sqrt{\pi}} \int_0^{\frac{y_o}{\sigma_y \sqrt{2}}} e^{-t^2} dt \quad (3)$$

The mainstream direction of the wind and the measured road is the vertical angle. The model was shown as following:

$$C = \left(\frac{2}{\pi} \right)^{\frac{1}{2}} \frac{Q}{\sin \theta \bar{u} \sigma_z} \operatorname{erf} \left(\frac{y_o / \sin \theta}{\sigma_y \sqrt{2}} \right) \quad (4)$$

$\sigma_z = \gamma_2 x^{a_2}$ is transverse diffusion coefficients. $\sigma_y = \gamma_1 x^{a_1}$ is vertical diffusion coefficients. Where: $x = dp / \sin \theta$

σ_z is transverse diffusion coefficients, σ_y is vertical diffusion coefficients, \bar{u} wind speed (m/s), θ is the angle of the main direction of the wind and the measured road, Q is the line source emission rate, (g/m*s), y_o is half length of the measured highway (m), dp is The vertical distance from receiver to linear source.

Flow Chart And Program Development

The CO₂ concentration measurement software that is compiled based on VB.net is a desktop application, whose interface is appealing and tractable. The main purpose is that the data is processed more quickly to improve the precision of the test.

(1) CO₂ concentration test flow chart is shown in FIG. 1

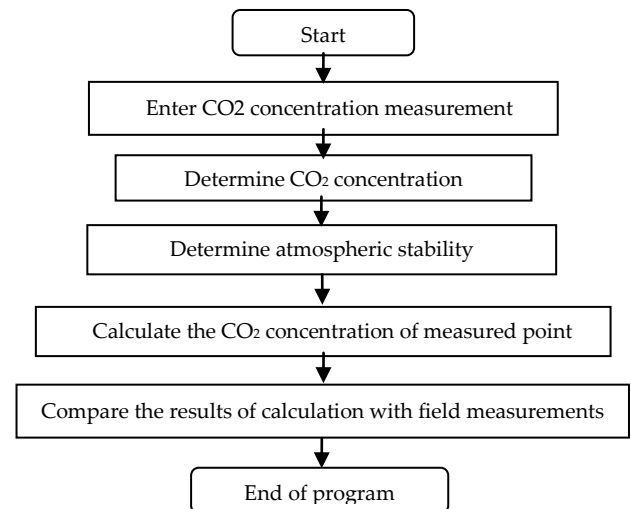
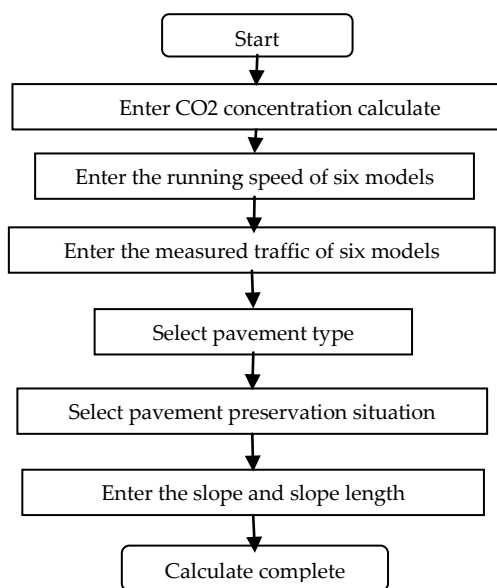


FIG. 1 CO₂ CONCENTRATION TEST FLOW CHART

Figure 1 shows the entire design of the software. First of all, the co2 concentration and atmospheric stability should be determined, then the co2 concentration of measured point is calculated, finally, the results of calculation are compared with field measurements. So the reliability of the carbon measurement model can be verified

(2) CO₂ concentration calculation flow chart is shown in FIG. 2.

FIG. 2 CO₂ CONCENTRATION CALCULATE FLOW CHART

(3) "Turner" model flow chart is shown in FIG. 3.

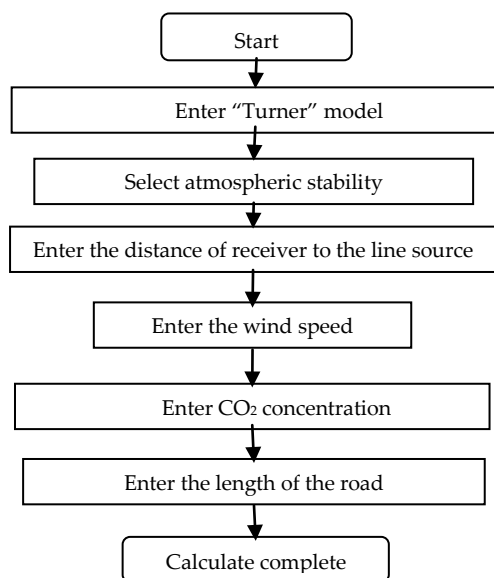


FIG. 3 "TURNER" MODEL FLOW CHART

Application Example

CO₂ concentration measurement software has been completed based on VB.net technology. The south third ring road from Shijiazhuang city of Hebei province is taken as an example to show the operation process of the software. Firstly, we enter a local latitude and longitude, local time, the wind speed and so on. Then by clicking "Computer", and atmospheric stability can be determined as shown in Figure 4.

Secondly, enter the running speed of six models, select pavement type, the slope and slope length, followed by pavement preservation situation; CO₂ concentration can be determined, as shown in Figure 5.

Lastly, the CO₂ concentration values of measured

point can be determined by "Turner" model, ss shown in Figure 6.



FIG. 4 DETERMINE ATMOSPHERIC STABILITY

FIG. 5 DETERMINE CO₂ CONCENTRATION

FIG. 6 "TURNER" MODEL INTERFACE

Conclusions

In the paper, the carbon measurement model has been established through the analysis of factors influencing highway carbon emissions. "Turner" model was used to prove the validity of the carbon measurement model. Various methods were integrated in the software platform, and carbon measurement of highway operation period was calculated with a simple and easy method. The research process and the construction of low carbon road were promoted. The study made a greater contribution to implementing low carbon emissions reduction targets.

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